Startle Deficits in Women with Sexual Assault-Related PTSD

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The startle reflex, a cross-species response to intense stimuli with abrupt onset, is characterized by considerable plasticity and behavioral flexibility that can be exploited to assess various cognitive, attentional, and sensory processes.[1] In recent years, a growing number of studies have reported on the eye-blink component of the startle response in combat veterans with posttraumatic stress disorder (PTSD).[2-7] However, the extent to which the neurobiologic alterations described in veterans with PTSD can be extended to other populations is currently unknown.

This investigation was designed to assess the acoustic startle response in treatment-seeking women with sexual assault-related PTSD. In this study the eye-blink response was recorded from both eyes because of evidence that lateralized deficits may exist in subjects with PTSD.[8,9]

METHODS

Subjects. Thirteen female civilian subjects with sexual assault-related PTSD (mean age 38.1, SD 7.5) and 16 healthy female civilian comparison subjects (mean age 37.6, SD 10.5) were recruited for this study. Each subject with PTSD met full symptom criteria for PTSD per Structured Clinical Interview for DSM-III-R diagnosis (SCID). Patients with PTSD were also administered the Mississippi PTSD Symptom Scale for civilian trauma.[10] In addition, all subjects were administered the Speilberger State/Trait Anxiety Inventory (STAI).[11]

Startle Testing. The acoustic stimuli were bursts of white noise delivered binaurally through headphones. There were three types of trial: two pulse-alone trials (40-ms duration bursts or white noise at 92 dB[A] and 102 dB[A]) and a prepulse + pulse trial (a 30-ms duration 70 dB[A] white noise delivered 120 ms before the onset of a 40-ms duration 102 dB[A] pulse). The orbicularis oculi electromyographic (EMG) activity was recorded with two disk electrodes (Ag/AgCl) placed below each eye.

RESULTS

TABLE 1 presents magnitude startle data in women with PTSD and in the comparison group. The magnitude of startle to the *first* startle stimulus was asymmetrically

TABLE 1. Mean Magnitude (μV) and Standard Error of Startle in Traumatized Women with PTSD and in the Comparison Group

Group		First	Block 1		Block 2	
			92 dB	102 dB	92 dB	102 dB
Comparison Group						
	Left	210.6	64.9	103.2	49.9	93.5
		(38.5)	(21.4)	(28.6)	(16.6)	(23.3)
	Right	214.4	68.6	115.2	53.9	93.0
		(42.8)	(23.8)	(33.1)	(24.5)	(17.9)
PTSD Group						
	Left	229.8	134.4	227.6	77.9	177.4
		(35.1)	(26.8)	(34.4)	(21.1)	(37.3)
	Right	178.7	103.2	166.3	58.2	147.9
		(33.2)	(19.0)	(25.6)	(12.3)	(31.3)

TABLE 2. Results of the Four-Way Interaction (Group × Eye × Block × Intensity of the Magnitude) Startle Data

Effects	df	E	*p*
Group	1,27	2.8	NS
Group × Eye	1,27	7.7	0.01
Group × Block	1,27	6.0	0.02
Group × Intensity	1,27	6.7	0.01
Group × Eye × Block	1,27	8.5	0.007
Group × Eye × Intensity	1,27	3.7	0.06
Group × Block × Intensity	1,27	0.5	NS
Group × Eye × Block × Intensity	1,27	6.6	0.01

distributed in the PTSD subjects but not in the comparison subjects. This was reflected by a significant Group X Eye of Recording interaction ($F(1,27) = 4.3$, $p < 0.04$) which was due to the greater magnitude of startle over the left eye than the right eye in PTSD subjects only (PTSD: $F(1,12) = 6.0$, $p < 0.03$; comparison subjects: NS).

TABLE 2 shows the results of the four-way ANOVA of the magnitude startle data. Although the overall magnitude of startle was not significantly greater in PTSD subjects than in comparison subjects, significant group differences were reflected by several significant interactions with the factor group, including four-way interaction.

These interactions were due to the fact that the magnitude of startle was lateralized (left > right) in PTSD patients ($F(1,12) = 7.79$, $p < 0.01$) but not in comparison ($F(1,16) = 0.002$) subjects. As a result, the magnitude of startle was greater in the PTSD group than in the comparison group over the left eye than the right. In addition, this laterality was affected by the intensity of the startle stimulus and the block of

stimulus delivery. It tended to be greater after the more intense startle stimulus and in block 1. Posthoc group comparison for each trial in each block indicated that startle magnitude was greater in PTSD patients than in comparison subjects only over the left eye in response to the 102-dB startle stimuli in blocks 1 ($t(27) = 2.8$, $p < 0.009$) and 2 ($t(27) = 2.0$, $p < 0.05$) and in response to the 92-dB startle stimuli in block 1 ($t(27) = 2.0$, $p < 0.05$). The prepulse inhibition effect was not lateralized and did not differ significantly between the two groups.

Effects of Time since Trauma. The patient group demonstrated a bimodal distribution in the time elapsed since the index trauma (range 2-6 years and 10-27 years). Individuals whose index trauma fell within the last 6 years (mean = 3.73, SD 1.97 years) were identified as the "recent" trauma group, and they were compared to the "long-standing" trauma group whose index trauma occurred more than 10 years (mean = 16.16 years, SD 6.17 years) prior to testing. The two groups did not significantly differ in age (recent trauma group: 38.8 years, SD 8.3 years; long-standing trauma group: 37.6 years, SD, 7.3 years).

The two PTSD groups were compared using the same ANOVAs as just described. There was a differential group asymmetry of the magnitude of startle to the *first* pulse-alone trial (Group X Eye of Recording: $F(1,11) = 5.6$, $p < 0.03$). This interaction was due to the greater magnitude of startle over the left eye (272.4 μV, SE 47.7 μV) than the right (182.0 μV, SE 44.6 μV) in the recent but not the long-standing trauma group (180.1 μV, SE 48.2 μV vs 174.9 μV, SE 54.3 μV). There was also a trend for the magnitude of eye blink recorded during the two blocks of pulse-alone trials to be differentially distributed over the two eyes in the recent and long-standing trauma groups (Group X Eye of Recording: $F(1,11) = 3.0$, $p = 0.11$). In the recent trauma group, the overall magnitude of eye blink was significantly greater over the left eye (175.2 μV, SE 48.1 μV) than the right (120.2 μV, SE 54.3 μV) eye ($t(6) = 2.5$, $p < 0.04$). In the long-standing trauma group, no significant difference was noted between the left (129.9 μV, SE 31.0 μV) and the right (117.4 μV, SE 28.1 μV) eye.

When compared to the comparison group, only the recent trauma group showed significant differences in startle reactivity. A differential group asymmetry of eye-blink magnitude was noted (first trial: $F(1,21) = 8.7$, $p < 0.008$); two blocks of trials: $F(1,21) = 10.8$, $p < 0.003$). Although the overall magnitude of startle tended to be greater in the recent trauma group than in the comparison group ($F(1,21) = 2.6$, $p = 0.12$), a greater difference was found over the left eye ($t(21) = 2.1$, $p < 0.04$).

DISCUSSION

This study provides the first objective evidence of acoustic startle deficits in women with PTSD. In addition, these findings add to the growing body of evidence for exaggerated acoustic startle in PTSD and suggest that some similarities in pathophysiology may exist in women and men with the disorder. The significantly greater startle responses over the left eye than the right in PTSD subjects suggest a laterality effect. Bremner *et al.*[23,24] reported decreased *right* hippocampal volume in male veterans with PTSD and decreased *left* hippocampal volume in civilian women with PTSD.

Coover and Levine[12] reported that lesions of the rat hippocampus may lead to an increase in startle. Therefore, it is conceivable that the exaggerated startle seen

over the *left* eye in women with PTSD may be due to left-sided hippocampal deficits, the effects of which on the startle response are exhibited through the ipsilaterally innervated (cranial nerve VII) left orbicularis oculi muscle.

Preclinical investigations in the rat indicate that unconditioned sensitization of the startle response can be observed for a long time following shock administration.[13] The amygdala is critically involved in shock sensitization of startle.[14] In a subgroup of individuals with PTSD, repeated exposure to trauma or a single intense trauma may sensitize startle. Startle sensitization, however, should dissipate with time after the traumatic event. In aplysia, short-term sensitization generally fades within 1 hour, but severe or repeated intense stress leads to more durable increases in reactivity.[15] This model may hold true in humans and is supported by findings of increased startle in the PTSD subjects of the "recent" than of the "long-standing" trauma group.

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